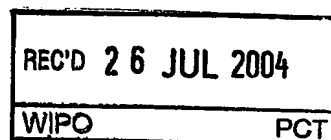




# Kongeriget Danmark

Patent application No.: PA 2003 00954  
Date of filing: 25 June 2003  
Applicant: Pharmexa A/S  
(Name and address) Kogle Allé 6  
DK-2970 Hørsholm  
Denmark



Title: Purification of her-2 variants

IPC: -

This is to certify that the attached documents are exact copies of the above mentioned patent application as originally filed.



Patent- og Varemærkestyrelsen  
Økonomi- og Erhvervsministeriet

20 July 2004

*Susanne Morsing*  
Susanne Morsing

**PRIORITY DOCUMENT**  
SUBMITTED OR TRANSMITTED IN  
COMPLIANCE WITH  
RULE 17.1(a) OR (b)

15450DK00

Modtaget PVS

25 JUNI 2003

1

## PURIFICATION OF HER-2 VARIANTS

### FIELD OF THE INVENTION

The present invention relates to the field of affinity purification of proteins. More particularly, the present invention relates to improvements in metal affinity protein purification, especially purification of histidine tagged or histidine rich proteins that have been recombinantly produced in insect cells. The invention also relates to specific purification schemes suitable for histidine-tagged protein variants derived from the EGFR (endothelial growth factor receptor) family of proteins, especially the cancer-associated antigen HER-2.

Further, the present invention relates to an immunogenic variant of human HER-2 that is capable of raising an immune response in humans, which also targets the native human HER-2 molecule.

### BACKGROUND OF THE INVENTION

The cancer associated membrane protein HER-2 is a member of the EGFR family of proteins. This particular protein has shown promise as an immunogen in active specific immunotherapy of certain cancers, notably breast cancer and colorectal cancer.

The assignee of the present patent application has previously filed patent applications relating to active vaccination against the HER-2 antigen, cf. WO 00/20027 which is hereby incorporated by reference herein. Further research in this field has now identified preferred HER-2 variants for such vaccines, but a general problem in protein chemistry is to

15450DK00

2

devise improved means for obtaining satisfactory yields of recombinant protein with a high degree of purity.

Immobilized metal ion affinity chromatography (IMAC) was first introduced by Porath (Porath, J., J. Carlsson, I. Olsson, G. Belfrage [1975] Nature 258:598-599.) under the term metal chelate chromatography and has been previously reviewed in several articles (Porath, J. [1992] Protein Purification and Expression 3:263-281; and articles cited therein). The IMAC purification process is based on the employment of a chelating matrix loaded with soft metal ions such as  $\text{Cu}^{2+}$  and  $\text{Ni}^{2+}$ . Electron-donating groups on the surface of proteins, especially the imidazole side chain of histidine, can bind to the non-coordinated sites of the loaded metal. The interaction between the electron donor group with the metal can be made reversible by lowering the pH or by displacement with imidazole. Thus, a protein possessing electron-donating groups such as histidine can be purified by reversible metal complex/protein interactions.

In 1991, Ford et al. (Ford, C., I. Suominen, C. Glatz [1991] Protein Expression and Purification 2:95-107) described protein purification using IMAC technology (Ni-NTA ligand) as applied to recombinant proteins having tails with histidine residues (polyhistidine recombinant proteins, "His-tagged proteins"). This method takes advantage of the fact that two or more histidine residues can cooperate to form very strong metal ion complexes.

Numerous variations of this technology exists, where the histidine residues are attached as "tags" to the relevant recombinant protein in various combinations, e.g. including recognition sites for specific proteases so that the his tag can be subsequently removed enzymatically.

Inspicos/25-06-03

15450DR00

3

Expression of proteins in insect cells require the use of various specialised culture media and also entails contamination of the recombinant protein with various insect cell derived constituents that are not found in bacteria, fungi and mammalian cells. Purification schemes devised for recombinant proteins produced in bacteria, fungi, or mammalian cells are therefore not necessarily the optimum choice when a protein produced in insect cells will need to be purified.

There is therefore a continuing need for improvements in protein purification in order to obtain pharmaceutical grade protein derived from recombinant production in insect cells.

---

#### OBJECT OF THE INVENTION

It is an object of the invention to provide an improved method for purifying recombinant EGFR family protein expressed in insect cells. It is a further object of the invention to provide an immunogenic variant of HER-2 protein that is usefull in e.g. cancer treatment by means of specific active immunotherapy.

#### SUMMARY OF THE INVENTION

The present inventors have devised a novel method for purifying EGFR family protein to a degree of purity, which is acceptable for pharmaceutical use, notaby for use as vaccine agents.

Hence, in one aspect, the present invention relates to a method for purification of an EGFR family derived protein, said protein being recombinantly produced in an insect cell culture and said protein being one that is suitable for

Inspicos/25-06-03

15450DK00

4

purification by means of immobilised metal affinity chromatography, the method comprising obtaining, from said insect cell culture, a substantially cell-free sample containing said EGFR family derived protein, and thereafter

- 5 enriching for said EGFR family derived protein by means of subsequent steps of
- diafiltration and exchange of culture medium with buffer,
  - immobilized metal affinity chromatography (IMAC),
  - size exclusion chromatography (SEC), and
  - 10 - anion exchange chromatography (AIE).

Another aspect of the invention relates to an immunogenic variant of HER-2 protein that comprises the amino acid

~~sequence set forth in SEQ ID NO: 2, residues 17-677.~~

#### LEGENDS TO THE FIGURE

15 Fig. 1: Chromatographic profile of the IMAC.

The arrow indicates the 104.1 peak.

Fig. 2: Chromatographic profile of the SEC.

The arrow indicates the monomer peak.

Fig. 3: Chromatographic profile of the AIE.

20 The arrow indicates the 104.1 peak.

Fig. 4: The pMT/hHER2MA5-5DUniHis vector p992, plasmid map.

hHER2MA5-5D: Gene coding for the hHER2MA5-5DUH protein (nucleotides 3604-5592).

P2 epitope: Sequence coding for the P2 epitope in the  
25 hHER2MA5-5DUH protein (nucleotides 4357-4401).

P30 epitope: Sequence coding for the P30 epitope in the hHER2MA5-5DUH protein (nucleotides 5500-5562).

SV40 late Polyadenylation site: Poly A signal (nucleotides

Inspicos/25-06-03

15450DK00

5

263-268).

ColE1: Origin of replication for replication in *E.coli*  
(nucleotides 701-1434).

Ampicillin resistance gene: Gene conferring ampicillin

5 resistance in bacteria (nucleotides 1579-2439).

Metallothionein promoter: Promoter that can be induced with a  
number of compounds (e.g. cadmium) (nucleotides 3050-3415).

Kozak like sequence: Ribosomal binding site (nucleotides 3493-  
3501).

10 BiP signal sequence: Signal sequence directing the HER2  
variant protein to secretion into the extracellular  
compartment (nucleotides 3502-3555).

UniHis sequence: Sequence coding for the UniHis tag used for  
purification of the HER2 AutoVac protein (nucleotides 3556-

15 3597).

Dipeptidase stop sequence: Used if the UniHis tag is to be  
cleaved from the HER2 AutoVac protein (nucleotides 3598-3603).

#### DETAILED DISCLOSURE OF THE INVENTION

In the following a number of term and expressions will be  
20 defined in the context of the present invention.

"An EGFR family derived protein" denotes a protein which is  
homologous to human EGFR (or ErbB-1); human HER-2/neu (ErbB-  
2); HER-3 (ErbB-3); or HER-4 (ErbB-4).

An "autologous" EGFR family protein is in the present  
25 specification and claims intended to denote an EGFR family  
polypeptide of an animal that is going to be vaccinated  
against its own EGFR family protein. In other words, the term  
is only relevant when the relation to the animal that it going  
to be vaccinated is considered.

Inspicos/25-06-03

15450DK00

6

The terms "T-lymphocyte" and "T-cell" will be used interchangeably for lymphocytes of thymic origin which are responsible for various cell mediated immune responses as well as for effector functions such as helper activity in the humeral immune response. Likewise, the terms "B-lymphocyte" and "B-cell" will be used interchangeably for antibody-producing lymphocytes.

An "antigen presenting cell" (APC) is a cell which presents epitopes to T-cells. Typical antigen-presenting cells are macrophages, dendritic cells and other phagocytizing and pinocytizing cells. It should be noted that B-cells also functions as APCs by presenting  $T_H$  epitopes bound to MCH class II molecules to  $T_H$  cells but when generally using the term APC in the present specification and claims it is intended to refer to the above-mentioned phagocytizing and pinocytizing cells.

"Helper T-lymphocytes" or " $T_H$  cells" denotes CD4 positive T-cells which provide help to B-cells and cytotoxic T-cells via the recognition of  $T_H$  epitopes bound to MHC Class II molecules on antigen presenting cells.

The term "cytotoxic T-lymphocyte" (CTL) will be used for CD8 positive T-cells which require the assistance of  $T_H$  cells in order to become activated.

A "specific" immune response is in the present context intended to denote a polyclonal immune response directed predominantly against a molecule or a group of quasi-identical molecules or, alternatively, against cells which present CTL epitopes of the molecule or the group of quasi-identical molecules.

Inspicos/25-06-03

7

15450DK00

7

The term "polypeptide" is in the present context intended to mean both short peptides of from 2 to 10 amino acid residues, oligopeptides of from 11 to 100 amino acid residues, and polypeptides of more than 100 amino acid residues. Furthermore, the term is also intended to include proteins, i.e. functional biomolecules comprising at least one polypeptide; when comprising at least two polypeptides, these may form complexes, be covalently linked, or may be non-covalently linked. The polypeptide(s) in a protein can be glycosylated and/or lipidated and/or comprise prosthetic groups.

The term "subsequence" means any consecutive stretch of at least 3 amino acids or, when relevant, of at least 3 nucleotides, derived directly from a naturally occurring amino acid sequence or nucleic acid sequence, respectively.

By the term "down-regulation an autologous EGFR family protein" is herein meant reduction in the living organism of the amount and/or activity of the relevant EGFR family protein. The down-regulation can be obtained by means of several mechanisms including removal of the CEA by scavenger cells (such as macrophages and other phagocytizing cells), and even more important, that cells carrying or harbouring the antigen are killed by CTLs in the animal.

The term "immunogen" is intended to denote a substance capable of inducing an immune response in a certain animal. It will therefore be understood that an autologous EGFR family protein is not an immunogen in the autologous host - it is necessary to use either a strong adjuvant and/or to co-present T helper epitopes with the autologous protein in order to mount an immune response against autologous protein and in such a case the "immunogen" is the composition of matter which is capable of breaking autotolerance.

Inspicos/25-06-03



15450DK00

8

The term "immunogenically effective amount" has its usual meaning in the art, i.e. an amount of an immunogen, which is capable of inducing an immune response which significantly engages pathogenic agents which share immunological features  
5 with the immunogen.

The term "pharmaceutically acceptable" has its usual meaning in the art, i.e. it is used for a substance that can be accepted as part of a medicament for human use when treating the disease in question and thus the term effectively excludes the  
10 use of highly toxic substances that would worsen rather than improve the treated subject's condition.

~~A "foreign T-cell epitope" is a peptide which is able to bind~~  
to an MHC molecule and which stimulates T-cells in an animal species. Preferred foreign epitopes are "promiscuous" epi-  
15 topes, i.e. epitopes, which binds to a substantial fraction of MHC class II molecules in an animal species or population. A term, which is often used interchangeably in the art, is the term "universal T-cell epitopes" for this kind of epitopes. Only a very limited number of such promiscuous T-cell epitopes  
20 are known, and they will be discussed in detail below. It should be noted that in order for the immunogens which are used according to the present invention to be effective in as large a fraction of an animal population as possible, it may be necessary to 1) insert several foreign T-cell epitopes in  
25 the same analogue or 2) prepare several analogues wherein each analogue has a different promiscuous epitope inserted. It should be noted that the concept of foreign T-cell epitopes also encompasses use of cryptic T-cell epitopes, i.e. epitopes which are derived from a self-protein and which only exerts  
30 immunogenic behaviour when existing in isolated form without being part of the self-protein in question.

Inspicos/25-06-03

15450DX00

9

A "foreign T helper lymphocyte epitope" (a foreign  $T_H$  epitope) is a foreign T cell epitope, which binds an MHC Class II molecule and can be presented on the surface of an antigen presenting cell (APC) bound to the MHC Class II molecule. It is also important to add that the "foreignness" feature therefore has two aspects: A foreign  $T_H$  epitope is 1) presented in the MHC Class II context by the animal in question and 2) the foreign epitope is not derived from the same polypeptide as the target antigen for the immunization - the epitope is thus also foreign to the target antigen.

A "CTL epitope" is a peptide, which is able to bind to an MHC class I molecule.

---

The term "adjuvant" has its usual meaning in the art of vaccine technology, i.e. a substance or a composition of matter which is 1) not in itself capable of mounting a specific immune response against the immunogen of the vaccine, but which is 2) nevertheless capable of enhancing the immune response against the immunogen. Or, in other words, vaccination with the adjuvant alone does not provide an immune response against the immunogen, vaccination with the immunogen may or may not give rise to an immune response against the immunogen, but the combined vaccination with immunogen and adjuvant induces an immune response against the immunogen which is stronger than that induced by the immunogen alone.

"Diafiltration" is a technique using ultrafiltration membranes to remove salt or solvent, exchange buffers, or fractionate different size biomolecules in macromolecular solutions. Macromolecules retained by the ultrafiltration membrane are concentrated while solvent and low molecular weight species are removed. However, a simple concentration of the macromolecular sample will not completely remove the smaller

Inspicos/25-06-03

154500K00

10

species. Therefore, the smaller species must be "washed" from the sample using multiple wash volumes (diafiltration). After the diafiltration process, the sample can be concentrated for further analysis or purification. This is an advantage

- 5 compared with gel filtration or dialysis when the sample can be diluted during the separation process, requiring an additional concentration step. There is no loss or contamination using diafiltration as could occur with a two-step process.

- 10 "Immobilised metal affinity chromatography" (IMAC) is a chromatographic technique where proteins are purified as a consequence of their affinity for certain divalent metal ions, cf. the description in the "Background of the invention".
- 

- 15 "Size exclusion chromatography" is a chromatographic technique, where proteins and other macromolecules are fractionated according to their physical size. Small molecules are retained in pores of the matrix and are therefore eluted slowly, whereas larger molecules are excluded and therefore eluted early from the matrix.

- 20 "Anion Exchange Chromatography" is a chromatographic technique, where molecules having a net negative charge are retained on the column matrix and subsequently eluted by displacing with anion from the elution buffer.

#### Description of the preferred embodiments

- 25 The present invention relates to a purification process that is especially tailored for purification of EGFR family derived proteins that have been produced recombinantly in insect cells. The present invention was conceived in connection with efforts that has led to the preparation of immunogenic

Inspicos/25-06-03

15450DR00

11

variants of the human cancer-associated antigen HER-2 - these variants are produced in the DES® expression system, an expression system owned by GlaxoSmithKline and marketed by i.a. Invitrogen. The system utilises S2 Drosophila cells and specialised vectors. The use of S2 cells as host cells for recombinant production has, however, posed its own set of problems to solve vis-à-vis the HER-2 variant in question, and these problems have been solved by using the inventive method (i.a. problems with co-migrating proteins which are derived from the S2 cells).

The particular protein that is used in the Examples is a variant of human HER-2, which is immunogenic in humans - the variant includes the amino acid sequence set forth in SEQ ID NO: 2, residues 17-677. However, since this amino acid sequence is not in itself suitable for IMAC, it contains an N-terminal histidine tag (amino acid residues 1-14 in SEQ ID NO: 1) that can be cleaved off by an aminodipeptidase (dipeptidyl peptidase I, DPPI, cf. Pedersen J et al., 1999, Protein Expression and Purification 15, 389-400). The stop sequence for the diaminopeptidase consists of residues 15 and 16 in SEQ ID NO: 2.

Therefore, in general the instant purification method is especially suited for EGFR family derived proteins that include a heterologous amino acid sequence that facilitates purification by means of IMAC. This sequence may be native to the EGFR family derived protein, but more often it is heterologous amino acid sequence (i.e. not naturally associated with the EGFR family derived protein). Preferred amino acid sequences for this purpose are rich in histidine residues (e.g. the His<sub>6</sub> tag and other amino acid sequences with several consecutive histidine residues). The most preferred heterologous amino acid sequence that facilitates IMAC

Inspicos/25-06-03

15450DK00

12

purification is the one comprising residues 1-14 of SEQ ID NO: 2.

The EGFR derived protein subjected to the inventive process is preferably one that comprises a substantial part of the amino acid sequence of human EGFR or human HER-2, and it is especially preferred that this substantial part is mainly derived from the extracellular portion of human EGFR or human HER-2. Most preferred is a variant of human HER-2, and in the most preferred embodiments, the variant of human HER-2 includes at least one foreign T helper cell epitope.

As mentioned above, the inventive process has been conceived ~~in connection with work on recombinant production of certain~~ variants of human HER-2 antigen. These variants are characteristic in including promiscuous foreign T-helper epitopes that are introduced into the amino acid sequence of human HER-2 extracellular domain. Preferred variants of human HER-2 include tetanus toxoid epitopes P2 (residues 269-282 of SEQ ID NO: 2) and P30 (residues 649-669 of SEQ ID NO: 2) and the most preferred variant has an amino acid sequence that consists of residues 1-677 of SEQ ID NO: 2

#### *Diafiltration/buffer exchange*

The step of diafiltration/buffer exchange is performed at a temperature from about 2 to about 25°C. However, preferably temperatures in the lower part of the range are used, e.g. temperatures below 20°C, such as below 15°C or below 10°C. Most preferred temperatures are in the range between 2 and 9°C, such as in the range between about 3°C and about 9°C, with a most preferred temperature range from about 4 to about 6°C. At higher temperatures (e.g. beyond 10°C) there is a tendency that

Inspicos/25-06-03

15450DR00

13

the protein aggregates, and this can be counteracted by adding a detergent, such as a Tween type detergent.

Normally, the diafiltration is performed in two rounds so as to initially concentrate macromolecular compounds in the sample of culture medium and thereafter to exchange culture medium with buffer. These procedures are done following standard procedures in the art, cf. also the examples. It is preferred that the concentration step results in a concentration of between 2 and 25 times of the macromolecular compounds, such as a concentration between 2 and 20 times, 3 and 15 times, between 3 and 10 times. Preferred concentration of macromolecular compounds is in the range of between 4 and 8 times, and the most preferred concentration is about 5 times.

---

The buffer exchange is typically performed in two subsequent steps of which the first takes place at a pH of at least 6.5 and at most 7.2 and of which the second takes place at a pH of at least 7.0 and of most 8.0. It is, however, possible to perform both steps at the same pH in the overlapping part of the two ranges. Typically, the buffer exchange is performed using a phosphate buffer.

After completion of the buffer exchange, the stringency of the following steps is preferably increased by adding an agent to the sample that will compete for binding to the chromatographic matrix in the IMAC step so as to reduce the amount of non-significant binding by contaminating constituents. For example, addition of imidazole, histidine or a high salt concentration buffer to the diafiltrated and buffer can be done to increase the stringency. Preferably, imidazole is added so as to reach a concentration in the range between about 0.05 to about 20 mM, preferably in the range from about 0.5 to about 15 mM, such as in the range from about

Inspicos/25-06-03

14

15450DR00

14

1 to about 10 mM. Especially preferred is concentration of imidazole in the range from about 2 to about 9 mM, such as a concentration from about 3 to about 8 mM. most preferred is an imidazole concentration of about 4 to about 6 mM, such as a  
5 concentration about 5 mM. When using a high salt concentration buffer (often NaCl), the concentration is in the range from 100 mM up to about 1 M.

It is also preferred to add a detergent to the diafiltrated and buffer changed sample prior to the IMAC step. The  
10 detergent will normally be selected from a polyoxyethylene sorbitan fatty acid ester such as Tween 20, Tween 40, Tween 60, Tween 80, and Tween 85, an alkylaryl polyether alcohol  
such as Triton X100, a non-ionic detergent, and a carbohydrate based detergent such as octylglycoside. The detergent is  
15 advantageously added to reach a concentration of between about 0.05% (v/v) and 10% (v/v), such as about 0.1% (v/v).

#### IMAC

The IMAC step involves charging of a chromatographic medium with a divalent metal ion prior to application of the buffer  
20 exchanged sample thereto. Typically, the divalent metal ion is selected from the group consisting of  $\text{Ni}^{2+}$ ,  $\text{Cu}^{2+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Co}^{2+}$ , and  $\text{Fe}^{2+}$ . Preferably, the divalent metal ion is  $\text{Zn}^{2+}$ .

Elution of the chromatographic medium in the IMAC is performed by applying imidazole, histidine, a high salt concentration  
25 buffer, or a change of pH onto the chromatographic medium (typically in a chromatographic column). For instance, when using imidazole for elution, this is advantageously done by applying the imidazole in one single step at a concentration between about 50 mM and about 500 mM (such as between 100 and  
30 400 mM), preferably at a concentration of about 200 mM.

Inspicos/25-06-03

15450DX00

15

Alternatively, when histidine is used this is done by applying the histidine in one single step at a concentration between about 20 mM and 400 mM (such as between 50 and 200 mM), preferably about 100 mM. The high salt concentration buffer usually contains NaCl in concentrations up to about 1 or even 2 M.

#### SEC

The average pore size of the SEC matrix is preferably one that separates globular protein between 10 kDa and 600 kDa.

- 10 After having applied the sample to the matrix, elution is done with a phosphate or TRIS buffer or, alternatively, with a biological buffer such as HEPES. It has surprisingly been found that phosphate buffers are suitable for the following AIE step, something which is normally considered
- 15 disadvantageous but the present inventors have encountered no problems in this respect.

pH is maintained in the range of about 7 to about 8 during the SEC and preferably the pH is kept about 7.5.

- If relevant and necessary (i.e. when a phosphate buffer is used in the SEC step), samples containing the EGFR family derived protein obtained from SEC, is diluted before the AIE step so as to adjust the phosphate concentration to less than 15 mM, such as to the range between 10 and 12.5 mM. However, it is, as mentioned above, surprising that the AIE can be
- 25 performed using such a phosphate buffer concentration.

#### AIE

The final step in the purification procedure of the invention is an AIE step. This step preferably involves loading of the

Inspicos/25-06-03



15450DK00

16

sample containing the EGFR family derived protein obtained after SEC on a strong or weak anion exchange matrix. Typically, the elution is performed with a buffered (phosphate, TRIS or a biological buffer such as HEPES) NaCl solution at a pH between 7 and 8, preferably about pH 7.5.

The protein obtained in the eluate after these four steps has a clinical grade purity and is substantially free of contaminants derived from the insect cell culture.

*HER-2 variant of the invention*

10 As mentioned above, the present inventive method has been conceived when purifying a variant of the human HER-2 tumour antigen. This particular variant has proven to be especially well-suited as a vaccine agent for inducing immunological reactions against autologous HER-2 so this particular variant  
15 is also a part of the present invention.

..... In general, the specific use, formulation, recombinant production, suitable vectors and host cells as well as other details pertaining to this specific HER-2 variant can be found in the disclosure of WO 00/20027. Hence, in the following only  
20 a brief discussion will be provided that specifically pertains to the variant. Hence, the disclosure of WO 00/20027 is included by reference herein and provides for the necessary teachings concerning immunization with HER-2 variants and the general methods for producing these and their formulation.  
25 Also the disclosure in WO 00/20027 relating to nucleic acid vaccination against autologous HER-2 is incorporated by reference herein.

As mentioned above, another aspect of the present invention relates to an immunogenic variant of HER-2 protein that

Insipicos/25-06-03

15450DK00

17

comprises the amino acid sequence set forth in SEQ ID NO: 2, residues 17-677. It is preferred that this variant is a polypeptide that consists of the amino acid sequence set forth in SEQ ID NO: 2, residues 1-677, i.e. a variant that also includes a histidiny-rich purification tag consisting of residues 1-14 in SEQ ID NO: 2, and an aminopeptidase stop sequence consisting of residues 15 and 16 in SEQ ID NO: 2.

Also included in the present invention is a nucleic acid fragment that encodes this immunogenic variant of HER-2 protein, such as a DNA fragment. An especially preferred DNA fragment has the HER-2 variant encoding sequence set forth in SEQ ID NO: 1.

---

Useful tools in the recombinant production of HER-2 variants are vectors carrying the nucleic acid fragment of the invention. Especially preferred is a vector capable of autonomous replication. Typically, the vector is selected from the group consisting of a plasmid, a phage, a cosmid, a mini-chromosome, and a virus.

Expression vectors are especially preferred. A typical expression vector of the invention comprises, in the 5'→3' direction and in operable linkage, a promoter for driving expression of the nucleic acid fragment of the invention, optionally a nucleic acid sequence encoding a leader peptide enabling secretion of or integration into the membrane of the polypeptide fragment, the nucleic acid fragment of the invention, and optionally a nucleic acid sequence encoding a terminator.

For recombinant production, a host cell transformed with the vector of the invention is especially preferred. A particularly interesting host cell is an insect cell, and most

Inspicos/25-06-03

15450DK00

18

preferred is a drosophila derived host cell such as an S2 cell.

Also part of the invention is a stable cell line which carries the vector of the invention and which expresses the nucleic acid fragment of the invention, and which optionally secretes or carries on its surface the immunogenic variant of HER-2 protein of the invention.

Furthermore, the invention also provides for an immunogenic composition for immunizing against HER-2 protein in a human comprising the immunogenic variant of HER-2 protein described above in admixture with a pharmaceutically acceptable carrier or vehicle and optionally an adjuvant. Details on suitable formulations can be found in WO 00/20027.

Alternatively, the vaccine may be in the form of a nucleic acid vaccine (for details concerning this technology, cf. WO 00/20027). Thus, also part of the invention is an immunogenic composition for immunizing against HER-2 protein in a human comprising the vector described above in admixture with a pharmaceutically acceptable carrier or vehicle and optionally an adjuvant

Also embraced by the scope of the present invention is a method for immunizing a human against autologous HER-2, the method comprising administering, to the human being, an immunogenically effective amount of

- the immunogenic variant of HER-2 protein described herein or an immunogenic composition comprising the variant, or
- the vector described herein or an immunogenic composition comprising said vector.

Inspicos/25-06-03

15450DR00

19

It is especially preferred that this immunization method (as well as the different means for immunization described herein) is used for treating or ameliorating cancer.

#### PREAMBLE TO THE EXAMPLES

- 5 The following exemplification utilizes the "104.1 molecule" (cf. SEQ ID NO: 2) which is an immunogenic analogue of the cancer associated HER-2 protein. However, it will be understood by the person skilled in the art that the general teachings of the present invention are applicable for other
- 10 His tagged proteins, especially those produced recombinantly in insect cell systems.
- 

The purification process consist of the following 4 general steps:

1. Diafiltration with buffer change of fermentation
- 15 supernatant.
2. Immobilized Metal Affinity Chromatography (IMAC)
3. Gelfiltration/Size Exclusion Chromatography (SEC)
4. Anion Exchange Chromatography (AIE)

#### Diafiltration/buffer exchange

- 20 The diafiltration serves three purposes 1) to concentrate the substance "104.1" 2) to remove low molecular weight substances from the fermentation medium that could interfere with the subsequent capture step, such as metal ions and 3) to change buffer into a buffer more suitable for metal chelate
- 25 chromatography (IMAC). Buffer exchange takes place in two

Inspicos/25-06-03

154500800

20

steps, first into 50 mM phosphate buffer pH 7.0 and then into 50 mM phosphate buffer pH 7.5. This pH sequence seems to be critical because going directly into pH 7.5 leads to precipitation of not identified components from the fermentation medium, when the fermentation medium is insect cell medium. Concentration is mainly performed to reduce loading time in the subsequent IMAC and to reduce consumption of buffer in the buffer exchange step and is not found essential for the process, as the subsequent IMAC by nature is a concentrating process step. The concentration scale is described to be 5 times but experiments using 10 times concentration also seem to work and it is expected that it is possible to go higher, such as 20 or even 25 times. Further concentration than the 5 times described in the protocol may improve the process, as it would decrease the loading time on the following IMAC column.

#### Sample preparation for IMAC

The diafiltrate is prior to application to the IMAC column prepared by adding imidazole to a final concentration of 0-10 mM. If no imidazole (or a similar substance) is added, we have experienced co-purification of other proteins from the insect cells with 104.1. Furthermore, Tween 20 is added (after filtration) to a final concentration of 0.1% (v/v). Up to 5% can be applied for the IMAC step and higher concentration than 0.1% will lead to less dimer formation. Other detergents are also expected to be useful, obviously other Tweens (Tween 40, 60, 80 and 85).

#### IMAC

The substance 104.1 has a so-called His-tag in the N-terminus that has affinity for complexed divalent metal ions

Inspicos/23-06-03

15450DK00

21

- immobilized on the column matrix. Critical parameters are choice of divalent metal ion and choice of elution agent/method.  $\text{Ni}^{2+}$ ,  $\text{Cu}^{2+}$  and  $\text{Zn}^{2+}$  can all be used as the chelating metal ion. However,  $\text{Zn}^{2+}$  has provided superior
- 5 recovery and fewer impurities. For elution of captured 104.1 several strategies can be used. 1) Application of imidazole to the column 2) application of histidine to the column 3) application of high salt concentration buffer to the column and 4) change of pH on the column.
- 10 The described process uses elution by application of 200 mM imidazole in one step. However, down to 50 mM can be used but the result is less concentrated 104.1 and lower recovery.
- 

### SEC

- The example below describes that the SEC is run in phosphate
- 15 buffer. However, TRIS seems to work as well and TRIS is more suitable for the following AIE than phosphate. The current protocol describes dilution of the SEC eluate before application on the AIE column in order to reduce the phosphate concentration, and this will not be necessary with TRIS. It is
- 20 nevertheless surprising the a phosphate buffer can be used at all.

- If the IMAC was run in Tween-20 concentration higher than 0.4%, it should be adjusted to < 0.4% in the SEC, as the 104.1 protein does not bind to the AIE column if the concentration
- 25 of Tween-20 is higher than 0.1%. This may be different if the AIE is run in TRIS instead of phosphate.

### Sample preparation for AIE Chromatography

The relevant fractions from SEC are diluted in water, 1 volume eluate + 3 water, to reduce the phosphate concentration as it

Inspicos/25-06-03

15450DK00

22

interferes with the AIE chromatography. This issue is also discussed in the SEC paragraph.

#### AIE Chromatography

The critical parameters are the pH and ionic strength of the sample and buffer systems.

If the SEC was run in TRIS the sample preparation (dilution in water) could be avoided and the loading volume (and loading time) would be reduced.

Final bulk product is analysed by SDS-PAGE, western blotting (WB), ELISA, HPLC, visual inspection, OD<sub>280</sub>, pH, Limulus

---

Amoebocyt Lysate (LAL) and amino acid analysis. Intermediate products are analysed by SDS-PAGE, WB, ELISA and OD<sub>280</sub>.

#### EXAMPLE 1

##### *Culturing of HER-2 variant 104.1*

#### 15 Cell line production

A polyclonal culture of S2 *Drosophila melanogaster* cells was transfected with a pMT vector (DES® system, Invitrogen) containing the gene coding for the HER2 variant 104.1; the entire nucleic acid sequence of this pMT vector is set forth in SEQ ID NO: 1. The cells were in parallel transfected with a plasmid carrying a gene conferring hygromycin resistance enabling the usage of hygromycin for selection of transfected cells.

Inspicos/25-06-03

15450DK00

23

A limited dilution technique was used for isolation of single cell clones and a Master Cell Bank (MCB) was produced from the selected cell line.

#### HER2 protein AutoVac production

- 5 One vial from the MCB is resuscitated in a T-flask and propagated in shake flasks containing ExCell420 media (JRH) at 25°C to obtain enough biomass for the inoculation of a bioreactor. A total of  $45 \times 10^9$  cells is diluted into 3000 mL with ExCell 420 supplemented with 4 mM Glutamine, 0.1 % Pluronic F68, and 0.5 mL/L PD30 antifoam. The 3000 mL are used to inoculate an Applikon bioreactor (7 L working volume) ~~where the culture grows for 3 days at 25°C,  $dO_2 = 50\%$  (100% -~~ air saturation), pH =  $6.5 \pm 0.1$  (adjusted with 5 %  $H_3PO_4$  and 0.5 M NaOH), and stirred at 170 rpm.
- 15 This culture is diluted with ExCell 420 supplemented with 4 mM Glutamine, 0.1% Pluronic F68, and 0.5 mL/L PD30 antifoam to a total cell concentration of  $15 \times 10^6$  cells/mL and used for inoculation of a 15 L working volume Applikon Bioreactor maintaining 25°C,  $dO_2 = 50\%$  (sparging with pure oxygen), pH = 6.5  $\pm$  0.1 (adjusted with 5 %  $H_3PO_4$  and 0.5 M NaOH), and stirred at 142 rpm. The culture is continuously diluted with ExCell 420 supplemented with 4 mM Glutamine and 0.1 % Pluronic F68 until a total volume of 10 L is reached. The dilution rate is adjusted daily to prevent the cell number to drop below  $15 \times 10^6$  cells/mL. PD30 antifoam is added manually to the culture to maintain a total concentration of 0.5 mL/L.
- 25

When filling is completed, perfusion is initiated at 1 RV/day (reactor volumes per day) using the BioSep cell (AppliSens) acoustic retention device to prevent cell loss with the removed media. At a cell concentration of  $30 \times 10^6$  cells/mL,

30

Inspicos/25-06-03



15450DX00

24

the culture is induced by addition of a total of 2  $\mu\text{M}$   $\text{CdCl}_2$  (10 mM stock) to the culture and to the medium reservoir.

The fermentation medium is harvested, centrifuged to obtain a cell free supernatant, and filtrated through a PALL filter

- 5 0.8/0.22  $\mu\text{m}$ . The resulting sterile supernatant is either stored at  $-80^\circ\text{C}$  until use (storage up to three months at  $-80^\circ\text{C}$  has not produced detectable stability problems) or stored at  $4^\circ\text{C}$  without for up to one week (also without any detectable degradation of the protein).

- 10 The culture is terminated 10 days post induction and the residual culture media in the bioreactor is discarded.
- 

## EXAMPLE 2

### *Diafiltration/Concentration and Buffer Change*

- Before use, the fermentation supernatant from Example 1 is, if  
15 kept at  $-80^\circ\text{C}$ , thawed slowly at  $4^\circ\text{C}$  over night (the last 3 to 4 hours in cold water), and thereafter stored for a maximum of 1 day at  $4^\circ\text{C}$ . Otherwise, the fermentation supernatant is used directly.

- The fermentation supernatant is centrifuged in a Sorvall RE 5C  
20 Plus Centrifuge in SCA3000 tubes at 10,000 rpm for 15 min, at  $4^\circ\text{C}$ .

- Diafiltration is performed in a cold room at  $4-6^\circ\text{C}$  on a ProFlux M12 (Millipore) with a Pellicon 2 Casette filter 30K 0.5  $\text{m}^2$  (Millipore, Cat# P2B030A05). The filter is before use stored  
25 in 0.1 M NaOH. Before diafiltration the filter is therefore thoroughly washed through with milli-Q water: The standard

Inspicos/25-06-03

15450DR00

25

reservoir is filled with milli-Q water (3L) and washed with water through the filter until 200 ml is left in the reservoir. This procedure is repeated 3 times until a total of 12 litres has passed through the filter. Now, diafiltration  
5 can be instigated:

A maximum of 15 L fermentation supernatant is concentrated 5 times: The recirculation pump is started. The backpressure valve should be partly locked, to give an outlet pressure that shows back pressure (e.g. 0.2 bar). The pump speed is adjusted  
10 to 30-50%. The pressure difference should show 0.7 - 1.2 Bar, as this is when the filter's maximum capacity is used and flow over filter correspond to 3-4 L/min (e.g. Outlet P=0.2 Bar, Inlet P=1.0 bar,  $\Delta P=0.8$ ). Inlet pressure should show max 1.4  
bar considering tubing life and performance. If a higher inlet  
15 pressure is desired, the recirculation pump pressure can be elevated (%) or the mechanical pressure on the tubing could be elevated by applying higher pressure on the tubing (scale 0-5). When the back pressure valve is closed, a higher inlet and higher outlet pressure is received. The back pressure valve  
20 should never be completely shut.

Subsequently, the concentrated fermentation supernatant is subjected to buffer exchange, first using 10 volumes 50 mM  $\text{Na}_2\text{HPO}_4/\text{NaH}_2\text{PO}_4$ , pH 7.0, and then by 10 volumes 50 mM  $\text{Na}_2\text{HPO}_4/\text{NaH}_2\text{PO}_4$ , pH 7.5: The standard reservoir on the ProFlux  
25 M12 Millipore apparatus is filled with buffer to a total volume of 3L and also the side reservoir is filled with buffer. The setting on the apparatus is the same as when concentrating the sample.

The volume of the buffer changed sample ( $V_b$ ) is measured and a  
30 a sample is taken out for SDS-PAGE ( $S_b$ ). The concentrated

Inspicos/25-06-03

15450DK00

26

buffer changed sample is portioned into 11 ml and 50 ml lots and frozen quickly to  $-80^{\circ}\text{C}$ .

#### Analysis of the Diafiltrate

pH and ionic strength is measured to assure efficiency of the 5 buffer exchange.

Total protein concentration is estimated spectrophotometrically at 280 nm in a 1 cm cuvette. A 10 times diluted sample (dilute in 50 mM sodiumphosphate buffer pH 7.5) with 50 mM sodium phosphate buffer pH 7.5 is used as reference (using the 10 approximation  $\text{Abs}_{280}$  of 1 = 1 mg/ml total protein). The specific concentration of variant 104.1 is measured by ELISA and the diafiltrate is furthermore analysed by SDS-PAGE, silver stained and WB-ECL detection.

#### Remarks to the Diafiltration Step

15 It is important to start the buffer exchange at pH 7.0 before changing to pH 7.5. Otherwise, residual components from the fermentation medium precipitate.

Diafiltered samples have been stored at  $-80^{\circ}\text{C}$  for several months without change in performance in the quantitative HER-2 20 ELISA. However, when thawed, even short exposure to  $37^{\circ}\text{C}$  and  $54^{\circ}\text{C}$  dramatically decreases the performance of the diafiltrate in the same ELISA. When kept at  $0^{\circ}\text{C}$  (ice/water) and  $4^{\circ}\text{C}$  after thawing from  $-80^{\circ}\text{C}$ , the performance in the ELISA of the diafiltrate is stable for up to at least 4 hours.

25 EXAMPLE 3

Inspicos/25-06-03

15450DX00

27

**IMAC**

The general chromatographic principle for IMAC is affinity between a "tag" on the protein and a metal ion chelate complex on the column matrix. The chromatographic matrix is POROS 20MC (Applied Biosystems) and the chelating metal ion is  $Zn^{2+}$ . The 104.1 molecule is provided with a His-tag and the buffer system for binding of the His-tag to the column matrix is 50 mM  $Na_2HPO_4/NaH_2PO_4$ , 5 mM Imidazol, 0.1 % Tween20, pH 7.5. Three mg 104.1 per ml column material is loaded and subsequently eluted using 200 mM Imidazol, 50 mM  $Na_2HPO_4/NaH_2PO_4$ , pH 7.5, 0.1 % Tween20.

---

~~Instrument: VISION Work Station (Applied Biosystems).~~

**Software:** Data analysis software for Vision, BioCAD 700E, version 3 series software, Perseptive Biosystem.

**15 Detection:** UV absorbance at  $\lambda = 280$  and 220 nm.

**Conductivity:** 0 - 200 mS

**pH calibrated at:** 7.0 and 10

**Temperature:** The procedure was made with buffers and column at room temperature (20-24°C) and loading of sample on ice and fraction collection at 10°C.

**Sample Preparation**

To the diafiltrate containing the 104.1 molecule, 800 mM imidazole is added to a final concentration of 5 mM imidazole. Immediately before application to the column the sample is filtrated by vacuum through OSMONICS AcetatePlus, Supported, plain, 0.22  $\mu m$  filter, (cat# A02SP04700) and Tween20 is added to a final concentration of 0.1% (v/v). The sample is kept at 4°C until application to the column where it is held on ice when applied. Handling time at room temperature should be minimized.

Inspicos/25-06-03

15450DR00

28

Column

POROS 20 MC in a 16 x 100 mm (20.1 ml) PEEK column (Applied Biosystems) packed at 2000-2500 psi.

Buffer Stocks

- 5 Buffer A: 250 mM  $\text{Na}_2\text{HPO}_4/\text{NaH}_2\text{PO}_4$ , pH 7.5, 0.5 % Tween20  
Buffer B:  $\text{H}_2\text{O}$  (Milli-Q)  
Buffer C: 12.5 mM Imidazol, pH 7.0  
Buffer D: 800 mM Imidazol, pH 7.0  
Buffer E: 0.1 M EDTA, 1 M NaCl, pH 4.2  
10 Buffer F: 100 mM  $\text{ZnCl}_2$ , pH 4.5/ Sample

---

Column Charge (strip-charge) Program

Flow: 10 ml/min.

1. 20 CV Buffer E (strip)  
2. 20 CV Buffer B  
15 3. 40 CV Buffer F  
4. 40 CV Buffer B

The column should be charged before each run.

Chromatography Program

- 20 Flow rate 30 ml/min, loading 5 ml/min.

Fraction collection size 9 ml, and 5 ml at elution peak 200 mM imidazole. Collect in a cooled (10°C) fraction collector.

1. Purge system 20 ml (30 ml/min)  
2. Equilibration: 20 CV 40 % buffer C, 20% buffer A  
25 3. Load: sample through pump, 5 ml/min.

Inspicos/25-06-03

15450DK00

29

4. Wash: 40 CV 40 % buffer C and 20% buffer A

5. Elution:

- 10 CV 25 % buffer D, 20% buffer A
- 5 CV 50 % buffer D, 20% buffer A
- 5     ▪ 5 CV 80 % buffer D, 20% buffer A

6. Wash: 20 CV buffer B (H<sub>2</sub>O)

Pool the fractions from the eluted peak from chromatogram (cf. Fig. 1). Begin pooling at peak start and collect a total of 50 ml or pool fractions based on SDS-PAGE/WB results or ELISA to a total of 50 ml. This pool can be saved over night at 4°C or carried on to SEC straight away. Storage of pool up 7 days at 4°C, -20°C and -80°C has shown no loss in total protein after filtration through 0.22 µm filter when analysed on SDS PAGE and WB-ECL.

#### Sanitization of column

Wash the column with 5 CV 1 M NaOH, 2 M NaCl, followed by 10 CV of water. If further sanitization is needed see the RSP from the manufacturer. The column is stored in 30% EtOH at 5-30°C.

#### Analysis of IMAC Intermediate

Start material, flow through and eluted fractions are analysed by WB-ECL and SDS-PAGE/silver stained.

#### Analysis of IMAC Pool

- 25 The pool is analyzed by WB-ECL and SDS-PAGE/silver stained, HPLC and OD<sub>280 nm</sub> (on 10 times diluted sample). The specific 104.1 concentration is determined by ELISA.

Inspicos/25-06-03

15450DK00

30

## EXAMPLE 4

*SEC Gel Filtration Chromatography*

The gelfiltration step is run in 50 mM Na<sub>2</sub>HPO<sub>4</sub>/NaH<sub>2</sub>PO<sub>4</sub>, 0.1% Tween20, pH 7.5. Fifty ml from IMAC of Example 3 is loaded by 5 Superloop (Pharmacia) on a Superdex 200 prep grade matrix.

**Instrument:** BioCAD 700E Work Station for Perfusion Chromatography equipped with a semi-preparative flow cell to reduce the back pressure on the column.

**Software:** Data analysis software for Vision, BioCAD 700E, 10 version 3 series software, Perceptive Biosystem.

**Detection:** UV absorbance at  $\lambda = 280$  and  $220$  nm.

---

**Conductivity:** 0 - 200 mS

**pH calibrated at:** 7.0 and 10

**Temperature:** Buffers and column are room temperature (20-24°C) 15 and the sample is loaded directly from 4°C. Fractions containing the monomer 104.1 should be moved to 4°C directly after collection if the collector is not cooled.

Sample Preparation

The Pool from IMAC in buffer, 50 mM Na<sub>2</sub>HPO<sub>4</sub>/NaH<sub>2</sub>PO<sub>4</sub>, 0.1% 20 Tween20, 200 mM imidazol, pH 7.5, requires no special preparation. The sample should be kept cool (4-6°C) until loading.

Column

Superdex 200 prep grade, packed in Pharmacia column XK 25 50x960mm (1884 ml) at 15 ml/min as final flow rate. Load maximum 50 ml.

Inspicos/25-06-03

15450DK00

31

Buffer StocksBuffer A: 250 mM Na<sub>2</sub>HPO<sub>4</sub>/NaH<sub>2</sub>PO<sub>4</sub>, pH 7.5, 0.5 % Tween20Buffer B: H<sub>2</sub>OChromatography Program

5 General flow rate 8 ml/min, load 5 ml/min.

Fraction size 9.0 ml

1. Equilibration 1.5 CV 20% buffer A (see remarks)
2. Load: via 50 ml Super Loop, 5 ml/min
3. Elution 1.2 CV 20% buffer A

---

10

The fractions from the monomer peak (cf. Fig. 2) are pooled by comparing gel results to obtain a pure product (approximately 130 ml). This pool can be saved over night at 4°C or carried on directly to the AIE chromatography of Example 5. Storage of  
15 pool up to 7 days at 4°C, -20°C and -80°C has shown no loss in total protein after filtration through 0.22 µm filter when analysed by SDS PAGE and WB-ECL.

Sanitization and cleaning of column

The column is cleaned by running 0.5 NaOH in the reversed flow  
20 direction for 1-2 h at 6.5 ml/min (20 cm/h) followed by 3 bed volumes of buffer. For sanitization run 0.5-1.0 NaOH in reversed flow direction, 13 ml/min (40 cm/h) for 30-60 min followed by 3-5 bed volumes of sterile buffer. The column is stored in 20% ethanol at 4-8°C. For additional information  
25 confer manufactures manual.

Inspicos/25-06-03



15450DK00

32

Analysis of the SEC Intermediate

Start material and eluted fractions are analyzed by WB-ECL and SDS-PAGE/silver stained.

Analysis of SEC Pool

- 5 The pool is analysed by WB-ECL and SDS-PAGE/silver stained, HPLC and OD<sub>280 nm</sub>. The specific 104.1 concentration is determined by ELISA.

Remarks to SEC

Make sure that the sample is kept at 4°C between IMAC and

10 loading from the Superloop.

If the fraction collector is not cooled (10°C) make sure that fractions are moved to cold room/fridge immediately after the collection.

- When the column is frequently used, a constant flow (0.2 ml/min) of 50 mM Na<sub>2</sub>HPO<sub>4</sub>/NaH<sub>2</sub>PO<sub>4</sub>, pH 7.5, 0.5% Tween 20 is applied to the column.
- 15

**EXAMPLE 5***AIE Chromatography*

- Anion exchange chromatography is performed at pH 7.5 (20 mM TRIS), preferably on a strong anion exchange perfusion matrix POROS 50HQ (Applied Biosystems) in a PEEK 4.6x100 mm (1.662 ml) column. 104.1 is eluted in 200 mM NaCl.
- 20

**Instrument:** VISION Work Station for Perfusion Chromatography.

**Software:** Data analysis software for Vision, BioCAD 700E,

Inspicos/25-06-03

15450DK00

33

version 3 series software, Perseptive Biosystem.

Detection: UV absorbance at  $\lambda = 280$  and  $220$  nm.

Conductivity:  $0 - 200$  mS

pH calibrated at:  $7.0$  and  $10$

- 5 Temperature: The procedure was made with buffers and column at room temperature ( $20-24^{\circ}\text{C}$ ) and loading of sample from ice. The fraction collector was cooled to  $10^{\circ}\text{C}$ .

#### Sample Preparation

The SEC intermediate is diluted 1+3 (to 25%) in water

- 10 containing 0.1% Tween20 under gentle magnetic stirring. The sample should be kept cool ( $4-6^{\circ}\text{C}$ ) until and during loading.
- 

#### Column

POROS 50HQ is packed in a  $4.6 \times 100$  mm ( $1.662$  ml) PEEK column (Applied Biosystems) at  $2000-2500$  psi.

#### 15 Buffer Stocks

Buffer A:  $100$  mM TRIS,  $0.5\%$  Tween20, pH  $7.5$

Buffer B:  $\text{H}_2\text{O}$

Buffer C:  $2$  M NaCl

Buffer D:  $2$  M NaOH,  $1$  M NaCl

- 20 Buffer E:  $100$  mM NaCl

Buffer F: Sample

#### Chromatography Program

General flow rate  $10$  ml/min, load sample  $5$  ml/min.

- 25 Fraction size:  $9$  ml during sample load,  $1$  ml during  $1^{\text{st}}$  elution step, and  $5$  ml during  $2^{\text{nd}}$  elution step

Inspicos/25-06-03

15450DK00

34

1. Purge System 20 ml (20 ml/min)
  2. Equilibration: 20 CV 20% buffer A
  3. Load sample via pump (5 ml/min)
  4. Wash: 10 CV wash in 20% buffer A
  - 5 5. Wash: 10 CV wash in 20% buffer A, 20% buffer E
  6. Elution:
    - 20 CV 20% buffer A, 10% buffer C
    - 10 CV 20% buffer A, 50% buffer C
- 10 The fractions from the elution peak (cf. Fig. 3) are pooled by comparing gel results to obtain a concentration of more than 1 mg/ml or OD<sub>280nm</sub> more than 1.0. The fractions can be kept over night at 4°C before pooled. Storage of pool up to 7 days at 4°C, -20°C and -80°C has shown no loss in total protein after
- 15 filtration through 0.22 µm filter when analysed by SDS PAGE and WB-ECL.

#### Sanitization of column

- Wash the column with 10 column volumes (CV) of 1 M NaOH, 2 M NaCl, followed by 20 CV of water. If further sanitization is
- 20 needed confer manufacturer's manual. The column is stored in 30% ethanol at 5-30°C.

#### Analysis

Start material, flow through and eluted fractions are analysed by WB-ECL and SDS-PAGE/silver stained.

#### 25 Analysis of AIE Pool

The pool is analysed by WB-ECL and SDS-PAGE/silver stained, Appearance and description, pH, HPLC, LAL and OD<sub>280 nm</sub> (use 3

Inspicos/25-06-03

15450DK00

35

times diluted sample). The specific 104.1 concentration is determined by ELISA.

Remarks to AIE

If the SEC intermediate is diluted less than 1 + 3 (25%) 104.1 is detected in the run-through from the AIE due to interference from the phosphate buffer.

Up to 25 mg 104.1 has been applied to the AIE column without detectable amounts of 104.1 in the run-through.

Storage of Final Bulk Product

- 10 The final bulk product is stored at -80°C in a polypropylene container after filtration through 0.22 µm filter.

The product thus obtained has a purity which is suitable for clinical use.

Inspicos/25-06-03

15450DR00

36

Modtaget PVS  
25 JUNI 2003

## CLAIMS

1. A method for purification of an EGFR family derived protein, said protein being recombinantly produced in an insect cell culture and said protein being one that is
- 5 suitable for purification by means of immobilised metal affinity chromatography, the method comprising obtaining, from said insect cell culture, a substantially cell-free sample containing said EGFR family derived protein, and thereafter enriching for said EGFR family derived protein by means of
- 10 subsequent steps of
- diafiltration and exchange of culture medium with buffer,
  - immobilized metal affinity chromatography (IMAC),
  - size exclusion chromatography (SEC), and
  - anion exchange chromatography (AIE).
- 15 2. The method of claim 1, wherein the EGFR family derived protein includes a heterologous amino acid sequence that facilitates purification by means of IMAC.
3. The method of claim 2, wherein the heterologous amino acid sequence is rich in histidine residues.
- 20 4. The method according to claim 3, wherein the heterologous amino acid sequence comprises residues 1-14 of SEQ ID NO: 2.
5. The method according to any one of the preceding claims, wherein the EGFR family derived protein comprises a substantial part of the amino acid sequence of human EGFR or
- 25 human HER-2.
6. The method according to claim 5, wherein the substantial portion is mainly derived from the extracellular portion of EGFR or HER-2.

Inspicos/25-06-03

15450DK00

37

7. The method according to claim 5 or 6, wherein the EGFR family derived protein is a variant of human HER-2.

8. The method according to claim 7, wherein the variant of human HER-2 includes at least one foreign T helper cell

5 epitope.

9. The method according to claim 8, wherein the variant of human HER-2 includes tetanus toxoid epitopes P2 (residues 269-282 of SEQ ID NO: 2) and P30 (residues 649-669 of SEQ ID NO: 2).

10 10. The method according to claim 9, wherein the variant of human HER-2 includes amino acid residues 17-677 of SEQ ID NO: 2.

11. The method according to claim 10, wherein the amino acid sequence of the variant of human HER-2 consists of residues 1-15 677 of SEQ ID NO: 2.

12. The method according to any one of the preceding claims, wherein the step of diafiltration/buffer exchange is performed at a temperature from about 2 to about 25°C, preferably at a temperature of about 4 to about 6°C, optionally with the 20 addition of a detergent such as Tween when the temperature is beyond 10°C.

13. The method according to claim 12, wherein the diafiltration is performed in two rounds so as to initially concentrate macromolecular compounds in the sample of culture 25 medium and thereafter to exchange culture medium with buffer.

Inspicos/25-06-03

15450DK00

38

14. The method according to claim 13, wherein the macromolecular compounds are concentrated between about 2 and about 25 times.

15. The method according to claim 14, wherein the 5 macromolecular compounds are concentrated about 5 times.

16. The method according to any one of claims 12-15, wherein the buffer exchange is performed in two subsequent steps of which the first takes place at a pH of at least 6.5 and at most 7.2 and of which the second takes place at a pH of at 10 least 7.0 and of most 8.0.

17. The method according to any one of claims 12-16, wherein a phosphate buffer is used for the buffer exchange.

18. The method according to any one of the preceding claims, wherein imidazole, histidine or a high salt concentration 15 buffer is added to the diafiltrated and buffer exchanged sample.

19. The method according to claim 18, wherein imidazole is added to reach a concentration of between about 0.05 to about 20 mM.

20 20. The method according to any one of the preceding claims, wherein a detergent selected from a Polyoxyethylene sorbitan fatty acid ester such as Tween 20, Tween 40, Tween 60, Tween 80, and Tween 85, an alkylaryl polyether alcohol such as Triton X100, a non-ionic detergent, and a carbohydrate based 25 detergent such as octylglycoside, is added to the diafiltrated and buffer exchanged sample to reach a concentration of between about 0.05% (v/v) and 10% (v/v), such as about 0.1% (v/v).

Inspicos/25-06-03

15450DK00

39

21. The method according to any one of the preceding claims, wherein the IMAC step involves charging of a chromatographic medium with a divalent metal ion prior to application of the buffer exchanged sample.
- 5 22. The method according to claim 21, wherein the divalent metal ion is selected from the group consisting of  $\text{Ni}^{2+}$ ,  $\text{Cu}^{2+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Co}^{2+}$ , and  $\text{Fe}^{2+}$ , preferably  $\text{Zn}^{2+}$ .
23. The method according to claim 21 or 22, wherein elution of the chromatographic medium is performed by applying  
10 imidazole, histidine, a high salt concentration buffer, or a change of pH onto the chromatographic medium.
24. The method according to claim 23, wherein elution of the chromatographic medium is performed by applying imidazole in one single step at a concentration between about 50 mM and  
15 about 500 mM, preferably at a concentration of about 200 mM, or wherein elution is performed by applying histidine in one single step at a concentration between about 20 mM and 400 mM, preferably about 100 mM.
25. The method according to any one of the preceding claims,  
20 wherein the SEC step involves elution with a phosphate or TRIS buffer or a biological buffer, such as HEPES.
26. The method according to claim 25, wherein the pH is maintained at about 7-8, preferably about 7.5.
27. The method according to claim 25 or 26, wherein the  
25 average pore size of the SEC matrix separates globular protein between 10 kDa and 600 kDa.
28. The method according to any of the preceding claims, wherein samples containing the EGFR family derived protein

Inspicos/25-06-03



15450DR00

40

obtained from SEC, if necessary, is diluted before the AIE step so as to adjust the phosphate concentration to less than 15 mM, such as to the range between 10 and 12.5 mM.

29. The method according to any one of the preceding claims,  
5 wherein the AIE step involves loading of the sample containing the EGFR family derived protein obtained after SEC on a strong or weak anion exchange matrix.

30. The method according to claim 29, wherein elution is  
10 performed with a buffered NaCl solution at a pH between 7 and 8.

31. An immunogenic variant of HER-2 protein that comprises the amino acid sequence set forth in SEQ ID NO: 2, residues 17-677.

32. The immunogenic variant of HER-2 protein according to  
15 claim 31 that consists of the amino acid sequence set forth in SEQ ID NO: 2, residues 1-677.

33. A nucleic acid fragment that encodes the immunogenic variant of HER-2 protein according to claim 31 or 32.

34. The nucleic acid fragment according to claim 33, which is  
20 a DNA fragment.

35. A vector carrying the nucleic acid fragment according to claim 33 or 34.

36. The vector according to claim 34, which is capable of autonomous replication.

Inspicos/25-06-03

15450DR00

41

37. The vector according to claim 34 or 36 being selected from the group consisting of a plasmid, a phage, a cosmid, a mini-chromosome, and a virus.

38. The vector according to any one of claims 34-37, which is  
5 an expression vector.

39. The vector according to claim 38, comprising in the 5'→3' direction and in operable linkage, a promoter for driving expression of the nucleic acid fragment according to claim 33 or 34, optionally a nucleic acid sequence encoding a leader  
10 peptide enabling secretion of or integration into the membrane of the polypeptide fragment, the nucleic acid fragment according to claim 33 or 34, and optionally a nucleic acid sequence encoding a terminator

40. A transformed host cell carrying the vector of any one of  
15 claims 34-39.

41. A stable cell line which carries the vector according to claim 38 or 39 and which expresses the nucleic acid fragment according to claim 33 or 34, and which optionally secretes or carries the immunogenic variant of HER-2 protein according to  
20 claim 31 or 32 on its surface.

42. An immunogenic composition for immunizing against HER-2 protein in a human comprising the immunogenic variant of HER-2 protein according to claim 31 or 32 in admixture with a pharmaceutically acceptable carrier or vehicle and optionally  
25 an adjuvant.

43. An immunogenic composition for immunizing against HER-2 protein in a human comprising the vector according to claim 38

inspicos/25-06-03

15450DK00

42

or 39 in admixture with a pharmaceutically acceptable carrier or vehicle and optionally an adjuvant

44. A method for immunizing a human against autologous HER-2, the method comprising administering an immunogenically

5 effective amount of

- the immunogenic variant of HER-2 protein according to claim 31 or 32, or

- the immunogenic composition according to claim 42, or

- the vector according to claim 38 or 39, or

10 - the immunogenic composition according to claim 43, to the human being.

45. The method according to claim 44 wherein the immunization against autologous HER-2 protein is used for treating or ameliorating cancer.

Inspicos/25-06-03

15450DK00

Modtaget PVS

25 JUN 2003

1

## SEQUENCE LISTING

<110> Pharmexa A/S  
<120> PURIFICATION OF HER-2 VARIANTS  
<130> P1020DK00  
<160> 2  
<170> PatentIn version 3.2  
<210> 1  
<211> 5661  
<212> DNA  
<213> Artificial sequence  
<220>  
<223> Recombinant expression plasmid derived from pMT  
  
<220>  
<221> polyA\_signal  
<222> (263)..(268)  
<223> SV40 late polyadenylation site  
  
<220>  
<221> misc\_feature  
<222> (1579)..(2439)  
<223> Ampicillin resistance gene, encoded by complementary strand  
  
<220>  
<221> promoter  
<222> (3050)..(3415)  
<223> Metallothionein promoter  
  
<220>  
<221> RBS  
<222> (3493)..(3501)  
<223> Kozak-like sequence  
  
<220>  
<221> CDS  
<222> (3502)..(5592)  
<223> DNA encoding immunogenic, his-tagged variant of human HER-2  
  
<220>  
<221> sig\_peptide  
<222> (3502)..(3555)  
<223> BiP signal sequence  
  
<220>  
<221> misc\_feature  
<222> (3556)..(3597)  
<223> Histidine tag  
  
<220>  
<221> mat\_peptide  
<222> (3556)..(5589)

Inspicos/25-06-03

15450DK00

2

<220>  
 <221> misc feature  
 <222> (3598)..(3603)  
 <223> Dipeptidase stop sequence

<220>  
 <221> misc feature  
 <222> (3604)..(5589)  
 <223> Gene coding for the hHER2MA5-5DUR protein

<220>  
 <221> misc feature  
 <222> (4357)..(4401)  
 <223> Diphtheria toxoid P2 epitope

<220>  
 <221> misc feature  
 <222> (5500)..(5562)  
 <223> Diphtheria toxoid P30 epitope

<400> 1  
 ggccgctcga gtctagaggg cccttcgaag gtaagcctat ccctaaccct ctccctcggtc 60  
 tcgattctac gcgtaccggt catcatcacc atcaccattg agtttaaacg cgctgatcag 120  
 cctcgactgt gccttctaag atccagacat gataagatac attgatgagt ttggacaaac 180  
 cacaactaga atgcagtga aaaaatgctt tatttgtgaa atttctgatg ctattgcttt 240  
 atttgtaacc attataagct gcaataaaca agttaacaac aacaattgca ttcatTTTTat 300  
 gtttcagggt cagggggagg tgtgggaggt tttttaaaac aagtaaaacc tctacaaatg 360  
 tgggtatggc gattatgac agtcgacctg caggcatgca agcttggcgt aatcatggtc 420  
 atagctgttt cctgtgtgaa attgttatcc gtcacaaatt ccacacaaca tacgagccgg 480  
 aagcataaag tgtaaacctt ggggtgccta atgagtgagc taactcacat taattgcgtt 540  
 gcgctcactg ccgcttttcc agtcgggaaa cctgtcgtgc cagctgcatt aatgaatcgg 600  
 ccaacycgcg gggagaggcg gtttgcgat tgggcgctct tccgcttccg cgctcactga 660  
 ctgctgcgc tcggtcgttc ggctgcggcg agcgggtatca gctcactcaa aggcggtaat 720  
 acggttatcc acagaatcag gggataacgc aggaagaac atgtgagcaa aaggccagca 780  
 aaaggccagg aaccgtaaaa aggccgcgtt gctggcggtt ttccataggc tccgcccccc 840  
 tgacgagcat cacaaaaatc gacgctcaag tcagaggtgg cgaaaaccga caggactata 900  
 aagataccag gcgtttcccc ctggaagctc cctcgtgcgc tctcctgttc cgacctgcc 960  
 gcttaccgga tacctgtcgc cctttctccc ttcgggaagc gtggcgcttt ctcatagctc 1020  
 acgctgtagg tatctcagtt cgggtgtagg cgttcgctcc aagctgggct gtgtgcacga 1080  
 accccccgtt cagccccgac gctgcgcctt atccggtaac tatcgtcttg agtccaacco 1140  
 ggtaagacac gacttatcgc caotggcagc agccactggg aacaggatta gcagagcgag 1200

Inspicos/25-06-03

15430DR00

3

gtatgtaggc ggtgctacag agttcttgaa gtggtggcct aactacggct acactagaag 1260  
 gacagtattt ggtatctgcg ctctgctgaa gccagttacc ttcggaaaaa gagttggtag 1320  
 ctcttgatcc ggcaaacaaa ccaccgctgg tagcgggtggt ttttttggtt gcaagcagca 1380  
 gattacgcgc agaaaaaag gatctcaaga agatcctttg atcttttcta cggggtctga 1440  
 cgctcagtgg aacgaaaact cacgttaagg gattttggtc atgagattat caaaaaggat 1500  
 cttcacotag atccttttaa attaaaaatg aagttttaaa tcaatctaaa gtataalga 1560  
 gtaaaacttg tctgacagtt accaatgctt aatcagttag gcacctatct cagcgatctg 1620  
 tctatttcgt tcatccatag ttgctgact ccccgctcgt tagataacta cgatacggga 1680  
 gggcttacca tctggcccca gtgctgcaat gataccgcga gacccacgct caccggctcc 1740  
 agatttatca gcaataaacc agccagccgg aagggccgag cgcagaagtg gtcctgcaac 1800  
 tttatccgcc tccatccagt ctattaattg ttgccgggaa gctagagtaa gtagttcgcc 1860  
 agttaatagt ttgcgcaacg ttgttgccat tgctacaggc atcgtggtgt cacgctcgtc 1920  
 gtttggtatg gcltcattca gctccggtc ccaacgatca aggcgagtta catgatcccc 1980  
 catgttggtc aaaaaagcgg ttagctcctt cggctcctccg atcgttggtc gaagtaagtt 2040  
 ggcgcgagtg ttatcaotca tggttatggc agcactgcat aattctctta ctgtcatgcc 2100  
 atccgtaaga tgcttttctg tgactgggtg gtactcaacc aagtcattct gagaatagtg 2160  
 tatgcggcga ccgagttgot cttgcccggc gtaatacgg gataatcog cggcacatag 2220  
 cagaacttta aaagtgtc tcatggaaa acgttcttcg gggcgaaaaa tctcaaggat 2280  
 cttaccgctg ttgagatcca gttcgatgta acccactcgt gcacccaact gatcltcagc 2340  
 atcttttact ttcaccagcg tttctgggtg agcaaaaaca ggaaggcaaa atgccgcaaa 2400  
 aaagggata aggyugacac ggaatgttg aatactcata ctcttccttt ttcaatatta 2460  
 ttgaagcatt tatcagggtt attgtctcat gagcggatac atatttgaat gtatttagaa 2520  
 aaataaaca ataggggttc cgcgcacatt tccccgaaaa gtgccacctg acgtctaaga 2580  
 aaccattatt atcatgacat taacctataa aaataggcgt atcaogaggc ctttcggtc 2640  
 gcgcgtttcg gtgatgacgg tgaaaacctc tgacacatgc agctcccgga gacggtcaca 2700  
 gcttgctctg aagcggatgc cgggagcaga caagcccgtc agggcgcgtc agcgggtgtt 2760  
 ggcgggtgto ggggctggct taactatgcg gcatcagagc agattgtac yagaytgac 2820  
 catatgnggt gtgaaatacc gcacagatgc gtaaggagaa aataccgcat caggcgcoat 2880  
 tcgccatLca ggctgcgcaa ctgttgggaa gggcgatcgg tgcgggcctc ttcgctatta 2940  
 cgcagctgg cgaaaggggg atgtgctgca aggcgattaa gttgggtaac gccagggttt 3000

Inspicos/25-06-03

4

**Inspicon/25-06-03**

15450DX00

5

aac ccc cag ctc tgc tac cag gac acg att ttg tgg aag gac atc ttc Asn Pro Gln Leu Cys Tyr Gln Asp Thr Ile Leu Trp Lys Asp Ile Phe 155 160 165	4059
cac aag aac aac cag ctg gct ctc aca ctg ata gac acc aac cgc tct His Lys Asn Asn Gln Leu Ala Leu Thr Leu Ile Asp Thr Asn Arg Ser 170 175 180	4107
cqq gcc tgc cac ccc tgt tct ccg atg tgt aag ggc tcc cgc tgc tgg Arg Ala Cys His Pro Cys Ser Pro Met Cys Lys Gly Ser Arg Cys Trp 185 190 195 200	4155
gga gag agt tct gag gat tgt cag agc ctg acg cgc act gtc tgt gcc Gly Glu Ser Ser Glu Asp Cys Gln Ser Leu Thr Arg Thr Val Cys Ala 205 210 215	4203
ggt ggc tgt gcc cgc tgc aag ggg cca ctg ccc act gac tgc tgc cat Gly Gly Cys Ala Arg Cys Lys Gly Pro Leu Pro Thr Asp Cys Cys His 220 225 230	4251
gag cag tgt gct gcc ggc tgc acg ggc ccc aag cac tct gac tgc ctg Glu Gln Cys Ala Ala Gly Cys Thr Gly Pro Lys His Ser Asp Cys Leu 235 240 245	4299
gcc tgc ctc cac ttc aac cac agt ggc atc tgt gag ctg cac tgc cca Ala Cys Leu His Phe Asn His Ser Gly Ile Cys Glu Leu His Cys Pro 250 255 260	4347
gcc ctg gtc cag tac atc aaa gct aac tcc aaa ttc atc ggt atc acc Ala Leu Val Gln Tyr Ile Lys Ala Asn Ser Lys Phe Ile Gly Ile Thr 265 270 275 280	4395
gag ctg cgg tat aca ttc ggc gcc agc tgt gtg act gcc tgt ccc tac Glu Leu Arg Tyr Thr Phe Gly Ala Ser Cys Val Thr Ala Cys Pro Tyr 285 290 295	4443
aac tac ctt tct acg gac gtg gga tcc tgc acc ctc gtc tgc ccc ctg Asn Tyr Leu Ser Thr Asp Val Gly Ser Cys Thr Leu Val Cys Pro Leu 300 305 310	4491
cac aac caa gag gtg aca gca gag gat gga aca cag cgg tgt gag aag His Asn Gln Glu Val Thr Ala Glu Asp Gly Thr Gln Arg Cys Glu Lys 315 320 325	4539
tgc agc aag ccc tgt gcc cga gtg tgc tat ggt ctg ggc atg gag cac Cys Ser Lys Pro Cys Ala Arg Val Cys Tyr Gly Leu Gly Met Glu His 330 335 340	4587
ttg cga gag gtg agg gca gtt acc agt gcc aat atc cag gag ttt gct Leu Arg Glu Val Arg Ala Val Thr Ser Ala Asn Ile Gln Glu Phe Ala 345 350 355 360	4635
ggc tgc aag aag atc ttt ggg agc ctg gca ttt ctg ccg gag agc ttt Gly Cys Lys Lys Ile Phe Gly Ser Leu Ala Phe Leu Pro Glu Ser Phe 365 370 375	4683
gat ggg gac cca gcc tcc aac act gcc ccg ctc cag cca gag cag ctc Asp Gly Asp Pro Ala Ser Asn Thr Ala Pro Leu Gln Pro Glu Gln Leu 380 385 390	4731

Inspicos/25-06-03



15450DK00

6

caa gtg ttt gag act ctg gaa gag atc aca ggt tac cta tac atc tca Gln Val Phe Glu Thr Leu Glu Glu Ile Thr Gly Tyr Leu Tyr Ile Ser 395 400 405	4779
gca tgg ccg gac agc ctg cct gac ctc agc gtc ttc cag aac ctg caa Ala Trp Pro Asp Ser Leu Pro Asp Leu Ser Val Phe Gln Asn Leu Gln 410 415 420	4827
gta atc cgg gga cga att ctg cac aat ggc gcc tac tcg ctg acc ctg Val Ile Arg Gly Arg Ile Leu His Asn Gly Ala Tyr Ser Leu Thr Leu 425 430 435 440	4875
caa ggg ctg ggc atc agc tgg ctg ggg ctg cgc tca ctg agg gaa ctg Gln Gly Leu Gly Ile Ser Trp Leu Gly Leu Arg Ser Leu Arg Glu Leu 445 450 455	4923
ggc agt gga ctg gcc ctc atc cac cat aao acc cac ctc tgc ttc gtg Gly Ser Gly Leu Ala Leu Ile His His Asn Thr His Leu Cys Phe Val 460 465 470	4971
cac acg gtg ccc tgg gac cag ctc ttt cgg aac ccg cac caa gct ctg His Thr Val Pro Trp Asp Gln Leu Phe Arg Asn Pro His Gln Ala Leu 475 480 485	5019
ctc cac act gcc aac cgg cca gag gac gag tgt gtg ggc gag ggc ctg Leu His Thr Ala Asn Arg Pro Glu Asp Glu Cys Val Gly Glu Gly Leu 490 495 500	5067
gcc tgc cac cag ctg tgc gcc cga ggg cac tgc tgg ggt cca ggg ccc Ala Cys His Gln Leu Cys Ala Arg Gly His Cys Trp Gly Pro Gly Pro 505 510 515 520	5115
acc cag tgt gtc aac tgc agc cag ttc ctt cgg ggc cag gag tgc gtg Thr Gln Cys Val Asn Cys Ser Gln Phe Leu Arg Gly Gln Glu Cys Val 525 530 535	5163
gag gaa tgc cga gta ctg cag ggg ctc ccc agg gag tat gtg aat gcc Glu Glu Cys Arg Val Leu Gln Gly Leu Pro Arg Glu Tyr Val Asn Ala 540 545 550	5211
agg cac tqt ttg ccg tgc cac cct gag tgt cag ccc cag aat ggc tca Arg His Cys Leu Pro Cys His Pro Glu Cys Gln Pro Gln Asn Gly Ser 555 560 565	5259
gtg acc tgt ttt gga ccg gag gct gac cag tgt gtg gcc tgt gcc cac Val Thr Cys Phe Gly Pro Glu Ala Asp Gln Cys Val Ala Cys Ala His 570 575 580	5307
tat aag gac cct ccc ttc tgc gtg gcc cgc tgc ccc agc ggt gtg aaa Tyr Lys Asp Pro Pro Phe Cys Val Ala Arg Cys Pro Ser Gly Val Lys 585 590 595 600	5355
cct gac ctc tcc tac atg ccc atc tgg aag ttt cca gat gag gag ggc Pro Asp Leu Ser Tyr Met Pro Ile Trp Lys Phe Pro Asp Glu Glu Gly 605 610 615	5403
gca tgc cag cct tgc ccc atc aac tgc acc cac tcc tgt gtg gac ctg Ala Cys Gln Pro Cys Pro Ile Asn Cys Thr His Ser Cys Val Asp Leu 620 625 630	5451

Inspicon/25-06-03

13450DK00

7

gat gac aag ggc tgc ccc gcc gag cag aga gcc agc cct ctg acg tcc 5499  
Asp Asp Lys Gly Cys Pro Ala Glu Gln Arg Ala Ser Pro Leu Thr Ser  
635 640 645  
  
ttc aac aac ttc acc gtg agc ttc tgg ctg cgc gtg ccc aag gtg agc 5547  
Phe Asn Asn Phe Thr Val Ser Phe Trp Leu Arg Val Pro Lys Val Ser  
650 655 660  
  
gcc agc cac ctg gag atc gtc tct gcg gtg gtt ggc att ctg 5589  
Ala Ser His Leu Glu Ile Val Ser Ala Val Val Gly Ile Leu  
665 670 675  
  
tagaagcttg gtaccgagct cggatccact agtccagtgt ggtggaattc tgcagatata 5649  
cagcacagtgc gc 5661

<210> 2  
<211> 696  
<212> PRT  
<213> Artificial sequence

<220>  
<223> Recombinant expression plasmid derived from pSI

<400> 2

Met Lys Leu Cys Ile Leu Leu Ala Val Val Ala Phe Val Gly Leu Ser  
-15 -10 -5

Leu Gly Met Lys His Gln His Gln His Gln His Gln His Gln His Gln  
-1 1 5 10

Ala Pro Ser Thr Gln Val Cys Thr Gly Thr Asp Met Lys Leu Arg Leu  
15 20 25 30

Pro Ala Ser Pro Glu Thr His Leu Asp Met Leu Arg His Leu Tyr Gln  
35 40 45

Gly Cys Gln Val Val Gln Gly Asn Leu Glu Leu Thr Tyr Leu Pro Thr  
50 55 60

Asn Ala Ser Leu Ser Phe Leu Gln Asp Ile Gln Glu Val Gln Gly Tyr  
65 70 75

Val Leu Ile Ala His Asn Gln Val Arg Gln Val Pro Leu Gln Arg Leu  
80 85 90

Arg Ile Val Arg Gly Thr Gln Leu Phe Glu Asp Asn Tyr Ala Leu Ala  
95 100 105 110

Inspicos/25-06-03

15450DK00

8

Val Leu Asp Asn Gly Asp Pro Leu Asn Asn Thr Thr Pro Val Thr Gly  
 115 120 125

Ala Ser Pro Gly Gly Leu Arg Glu Leu Gln Leu Arg Ser Leu Thr Glu  
 130 135 140

Ile Leu Lys Gly Gly Val Leu Ile Gln Arg Asn Pro Gln Leu Cys Tyr  
 145 150 155

Gln Asp Thr Ile Leu Trp Lys Asp Ile Phe His Lys Asn Asn Gln Leu  
 160 165 170

Ala Leu Thr Leu Ile Asp Thr Asn Arg Ser Arg Ala Cys His Pro Cys  
 175 180 185 190

Ser Pro Met Cys Lys Gly Ser Arg Cys Trp Gly Glu Ser Ser Glu Asp  
 195 200 205

Cys Gln Ser Leu Thr Arg Thr Val Cys Ala Gly Gly Cys Ala Arg Cys  
 210 215 220

Lys Gly Pro Leu Pro Thr Asp Cys Cys His Glu Gln Cys Ala Ala Gly  
 225 230 235

Cys Thr Gly Pro Lys His Ser Asp Cys Leu Ala Cys Leu His Phe Asn  
 240 245 250

His Ser Gly Ile Cys Glu Leu His Cys Pro Ala Leu Val Gln Tyr Ile  
 255 260 265 270

Lys Ala Asn Ser Lys Phe Ile Gly Ile Thr Glu Leu Arg Tyr Thr Phe  
 275 280 285

Gly Ala Ser Cys Val Thr Ala Cys Pro Tyr Asn Tyr Leu Ser Thr Asp  
 290 295 300

Val Gly Ser Cys Thr Leu Val Cys Pro Leu His Asn Gln Glu Val Thr  
 305 310 315

Ala Glu Asp Gly Thr Gln Arg Cys Glu Lys Cys Ser Lys Pro Cys Ala  
 320 325 330

Arg Val Cys Tyr Gly Leu Gly Met Glu His Leu Arg Glu Val Arg Ala  
 335 340 345 350

Inspicos/25-06-03

15450DK00

9

Val Thr Ser Ala Asn Ile Gln Glu Phe Ala Gly Cys Lys Lys Ile Phe  
 355 360 365

Gly Ser Leu Ala Phe Leu Pro Glu Ser Phe Asp Gly Asp Pro Ala Ser  
 370 375 380

Asn Thr Ala Pro Leu Gln Pro Glu Gln Leu Gln Val Phe Glu Thr Leu  
 385 390 395

Glu Glu Ile Thr Gly Tyr Leu Tyr Ile Ser Ala Trp Pro Asp Ser Leu  
 400 405 410

Pro Asp Leu Ser Val Phe Gln Asn Leu Gln Val Ile Arg Gly Arg Ile  
 415 420 425 430

Leu His Asn Gly Ala Tyr Ser Leu Thr Leu Gln Gly Leu Gly Ile Ser  
 435 440 445

Trp Leu Gly Leu Arg Ser Leu Arg Glu Leu Gly Ser Gly Leu Ala Leu  
 450 455 460

Ile His His Asn Thr His Leu Cys Phe Val His Thr Val Pro Trp Asp  
 465 470 475

Gln Leu Phe Arg Asn Pro His Gln Ala Leu Leu His Thr Ala Asn Arg  
 480 485 490

Pro Glu Asp Glu Cys Val Gly Glu Gly Leu Ala Cys His Gln Leu Cys  
 495 500 505 510

Ala Arg Gly His Cys Trp Gly Pro Gly Pro Thr Gln Cys Val Asn Cys  
 515 520 525

Ser Gln Phe Leu Arg Gly Gln Glu Cys Val Glu Glu Cys Arg Val Leu  
 530 535 540

Gln Gly Leu Pro Arg Glu Tyr Val Asn Ala Arg His Cys Leu Pro Cys  
 545 550 555

His Pro Glu Cys Gln Pro Gln Asn Gly Ser Val Thr Cys Phe Gly Pro  
 560 565 570

Glu Ala Asp Gln Cys Val Ala Cys Ala His Tyr Lys Asp Pro Pro Phe  
 575 580 585 590

Inspicos/25-06-03

15450DR00

10

Cys Val Ala Arg Cys Pro Ser Gly Val Lys Pro Asp Leu Ser Tyr Met  
595 600 605

Pro Ile Trp Lys Phe Pro Asp Glu Glu Gly Ala Cys Gln Pro Cys Pro  
610 615 620

Ile Asn Cys Thr His Ser Cys Val Asp Leu Asp Asp Lys Gly Cys Pro  
625 630 635

Ala Glu Gln Arg Ala Ser Pro Leu Thr Ser Phe Asn Asn Phe Thr Val  
640 645 650

Ser Phe Trp Leu Arg Val Pro Lys Val Ser Ala Ser His Leu Glu Ile  
655 660 665 670

Val Ser Ala Val Val Gly Ile Leu  
675

Inspicos/25-06-03

Modtaget PVS

25 JUN: 2003

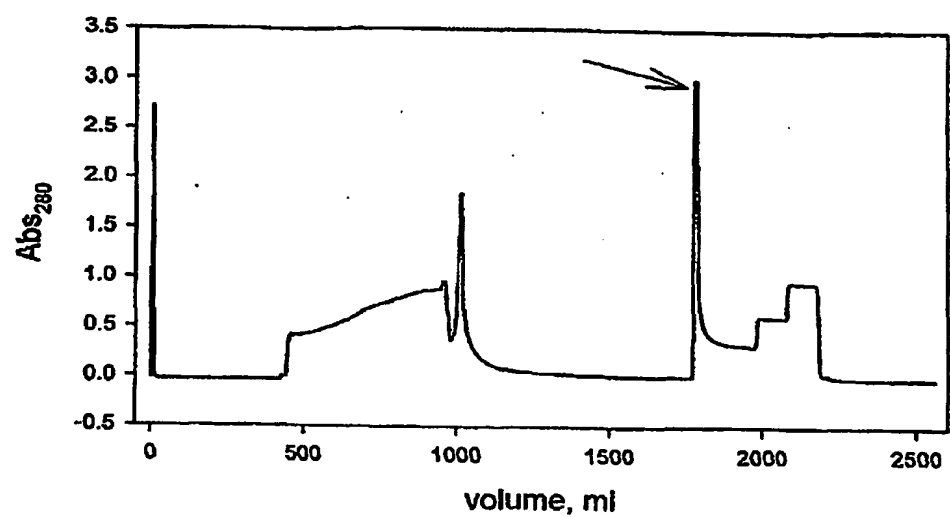


Fig. 1

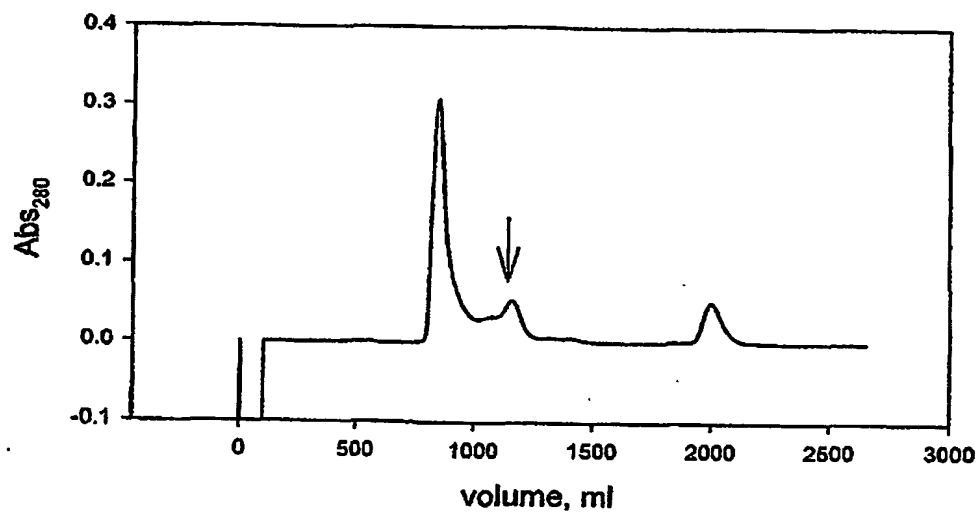


Fig. 2

25 JUN 2003

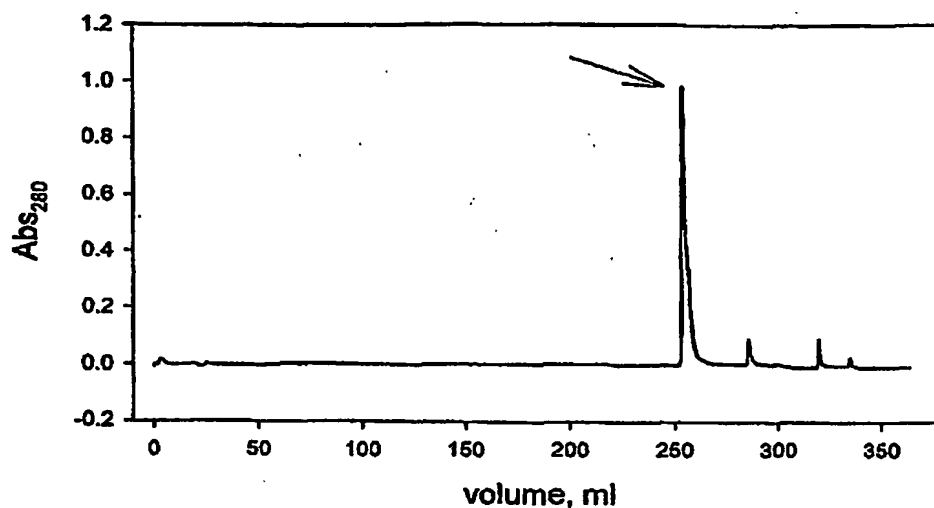


Fig. 3

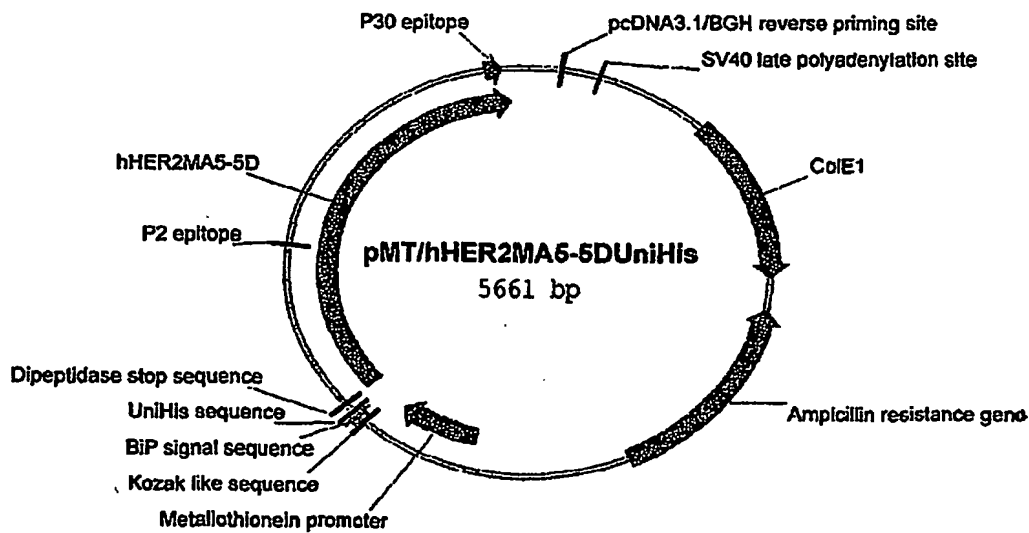


Fig. 4

**This Page is Inserted by IFW Indexing and Scanning  
Operations and is not part of the Official Record**

## **BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☒ **BLACK BORDERS**
- ☐ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- ☐ **FADED TEXT OR DRAWING**
- ☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- ☐ **SKEWED/SLANTED IMAGES**
- ☐ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- ☐ **GRAY SCALE DOCUMENTS**
- ☒ **LINES OR MARKS ON ORIGINAL DOCUMENT**
- ☐ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- ☐ **OTHER:** \_\_\_\_\_

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.**